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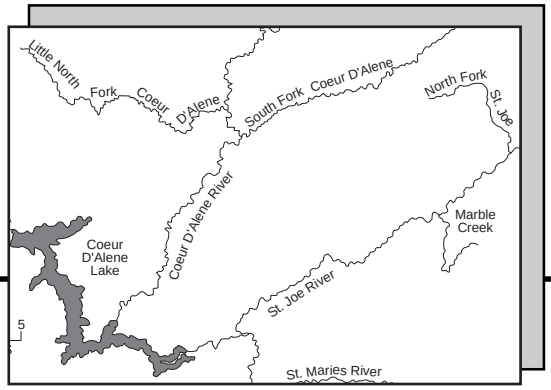

Fish Habitat Attributes of Reference and Managed Watersheds with Special Reference to the Location of Bull Charr (*Salvelinus confluentus*) Spawning Sites in the Upper Spokane River Ecosystem, Northern Idaho

David Cross
Forest Fisheries Program Manager
Idaho Panhandle National Forests
1201 Ironwood Dr.
Coeur d'Alene, ID 83814

Loren Everest
District Fisheries Biologist
Pineridge District, Sierra National Forest
P.O. Box 559
Prather, CA 93651

Abstract

On the Idaho Panhandle National Forests, bull charr and westslope cutthroat trout (*Oncorhynchus clarki lewisi*) are indicator species in the Forest Plan, listed as sensitive species by Region 1 of the USDA Forest Service and as species of special concern by the Idaho Department of Fish and Game. To address the needs of these species, and especially the bull charr with the recent petition for listing under the Endangered Species Act (ESA), the Idaho Panhandle National Forests began habitat typing unentered and entered watersheds in the upper Spokane River ecosystem in 1991. A physical habitat typing protocol developed in Region 5 of the USDA Forest Service and modified for the waters of northern Idaho was used to monitor any changes in fish habitat which may have occurred due to land management prescription. Of the attributes described by the methodology, mean residual pool volume and residual pool depth from managed and reference watersheds have been emphasized in analysis because of the value of pools in the stream ecology of bull charr and westslope cutthroat trout for rearing and overwintering habitat. Changes in the quality (volume and depth) and frequency of pool habitat (as a percent of the total length of stream), as a result of channel destabilization has a negative influence on carrying capacity as demonstrated by distribution and abundance of the two species in the Coeur d'Alene and St. Joe rivers, and appears to influence the distribution of spawning bull charr. Fish habitat attribute data from stream reaches of unentered watersheds in the upper St. Joe basin provide a reasonable standard by which to judge deviations seen in stream reaches of basins of similar geology, channel type, elevation, and forest type where management activities have occurred. These data have been fundamental to facilitating the development of a strategy to maintain ecosystems capable of supporting viable assemblages of bull charr and other native fishes.

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The USDA Forest Service Fish Habitat Relationships Program was established to further the development of fisheries technology and transfer this technology to field biologists. With ever increasing demands for natural resources, protection and management of aquatic communities requires biologists to be knowledgable of current research findings and state-of-the-art techniques. The purpose of *FHR Currents* is to provide a vehicle to quickly disseminate information important to field-level biologists in the USDA Forest Service.

Submissions:

If you wish to submit a paper for publication in *FHR Currents*, please contact the following people for information and guidelines:

Jerry Boberg/Karen Kenfield
Technical Editors
(707) 441-3669
Stephanie Gomes
Editor/Designer
(707) 441-3550

Six Rivers National Forest
Fisheries Department
1330 Bayshore Way
Eureka, CA 95501

Forest Service Fish Habitat Relationships Program Leaders or Representatives

National FHR Program

Jeffrey L. Kershner
Washington Office
Fish & Wildlife Department
Utah State University
Logan, UT 84322-5210

Region 1

Kathy Moynan, Northern Region
(Anadromous Fish Program)
Nez Perce National Forest
Route 2, Box 475
Grangeville, ID 83530

Brian Sanborn, Northern Region
(Resident Fish Program)
Deerlodge National Forest
Federal Building, Box 400
Butte, MT 59703

Region 2

R. Nick Schmal, Rocky Mountain Region
Wildlife, Fish & Botany Staff
Univ. of Wyoming, College of Agriculture
P.O. Box 3354
Laramie, WY 82071-3354

Region 3

Bryce Rickel, Southwest Region
Wildlife, Fish & Botany Staff
Federal Building
517 Gold Avel, S.W.
Albuquerque, NM 87102

Region 4

Seona L. Brown, Intermountain Region
Wildlife, Fish & Botany Staff
324 25th St.
Ogden, UT 84401

Region 5

Jerry Boberg, Pacific Southwest Region
(Anadromous Fish Program)
Six Rivers National Forest
1330 Bayshore Way
Eureka, CA 95501

Jeffery Reiner, Pacific Southwest Region
(Resident Fish Program)
Lake Tahoe Basin Management Unit
870 Emerald Bay Rd., Suite 1
South Lake Tahoe, CA 96150

Region 6

Deborah Konnoff, Pacific Northwest Region
Wildlife, Fish & Botany Staff
333 S.W. 1st Ave., P.O. Box 3623
Portland, OR 97208

Region 8

Cindy A. Williams, Southern Region
Wildlife, Fish & Botany Staff
1720 Peachtree Rd.
N.W. Atlanta, GA 30367

Region 9

Bob Hollingsworth, Northeast Region
USDA Forest Service
310 W. Wisconsin Ave.
Milwaukie, WI 53203

Region 10

Ron Dunlap, Alaska Region
Wildlife, Fish & Botany Staff
Federal Office Building, Box 21628
Juneau, AK 99802-1628

Intermountain/Northern Region

Kerry Overton, Fish Research Work Unit
Intermountain Research Station
316 E. Myrtle St.
Boise, ID 83702

Associates

Glenn Chen
Fisheries Biologist/Monitoring Specialist,
USDA Forest Service
Fish & Wildlife Department
Utah State University
Logan, UT 84322-5210

Fred Mangum
Aquatic Ecosystem Analysis Lab
105 Page School
Brigham Young University
Provo, UT 84602

Ken Roby
Hydrologist, USDA Forest Service
Pacific Southwest Experiment Station
P.O. Box 245
Berkeley, CA 94701-0245

Larry Schmidt
Stream Systems Technology Center
USDA Forest Service
Rocky Mountain Experiment Station
240 W. Prospect
Fort Collins, CO 80526-2098

Mark Vinson
Hydrologist/Monitoring Specialist,
USDI Bureau of Land Management
Fish & Wildlife Department
Utah State University,
Logan, UT 84322-5210

Introduction

Located in northern Idaho, the Idaho Panhandle National Forests encompass three proclaimed forests: the Coeur d'Alene, established in 1906; the Kaniksu, established in 1908, and the St. Joe, established in 1911. The Coeur d'Alene and St. Joe rivers flow into Lake Coeur d'Alene and together form the headwaters of the Spokane River (Figure 1). Since the establishment of the Forests, these two drainages have been largely managed by the USDA Forest Service. The area in and around Coeur d'Alene was settled in the 1870s after the discovery of gold and silver. Timber harvesting, beginning early in these drainages, must have been dramatic, for in 1888 General Sherman, of Civil War fame, would decline his earlier notion of retiring to Coeur d'Alene because, "Gold was discovered there, a railroad built, and the beautiful forests are being swept away, and the virgin lakes and streams robbed of their trout..." (Royster 1991). Using railroads, splash dams and log drives, the lower St. Joe drainage, and much of the Coeur d'Alene drainage in particular, was systematically harvested. At least twenty railroad systems with 300 miles of track and 11 splash dams were used in the Coeur d'Alene drainage (Cort Sims, USDA Forest Service personnel communication). On the St. Joe, splash dams were used principally in the lower tributaries such as Marble Creek and Slate Creek until the early 1930s. In 1910 and again in the 1930s, both the Coeur d'Alene and St. Joe drainages were burned by particularly large and hot fires. Heavy salvage logging followed.

Westslope cutthroat trout (*Oncorhynchus clarki lewisi*) and bull charr (*Salvelinus confluentus*) are the native trout and charr of the Spokane drainage above the outlet of Lake Coeur d'Alene and are present today in varying degrees of security. Bull charr are presently considered to be at high risk of extinction in the Coeur d'Alene watershed (Cross 1992). The United States Fish and Wildlife Service has found the bull charr warranted for listing under the Endangered Species Act but precluded due to their present work load. This paper compares and contrasts managed and reference watersheds in the St. Joe and Coeur d'Alene basins relative to stream channel condition, and fish habitat attributes, and discusses the distribution of spawning bull charr in the upper Spokane River ecosystem.

Methods

Watersheds were stratified into managed and reference based on their past management history. Watersheds without a past history of roading, logging, or mining were identified as reference.

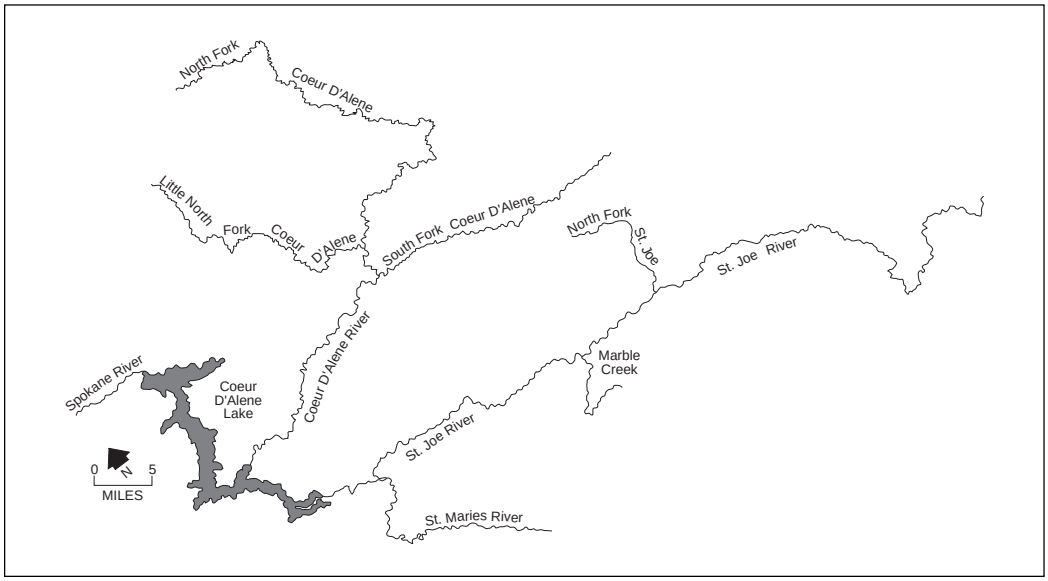

Figure 1. Upper Spokane River Ecosystem, northern Idaho. A natural barrier falls at the outlet of Lake Coeur d'Alene isolating this ecosystem from the rest of the Columbia River basin.

Both managed and reference watersheds had experienced stand replacing fires in 1910. Data on channel stability, fish habitat and spawning distribution of bull charr were collected from managed and reference sub-basins in the St. Joe and Coeur d'Alene watersheds. To evaluate channel stability, the Forests used the Riffle Armor Stability Index (RASI) (Kappesser 1992). This methodology characterizes the particle size distribution on riffles using a Wolman pebble count and determines the largest particles moved at bank full (channel forming) flows. The largest commonly occurring size of particle from the point bar is indexed to the cumulative particle size distribution of bed material on the riffle. The cumulative percent of riffle material finer than the common large particle size on the depositional feature is used as an index of channel equilibrium. In Belt geology drainages of the Idaho Panhandle indice values between 45 and 70 suggest conditions of dynamic equilibrium (Gary Kappesser, USDA Forest Service, personnel communication). For each stream, data were collected from three sets of riffles per Rosgen (1985) "B" channel type. RASI data were not collected in "A" channels due to a lack of time and manpower. These data provide the basis for establishing the present stability of the channel at the point of evaluation.

Surveys of fish habitat were conducted at base flows. Surveys in streams in the St. Joe and Coeur d'Alene basins began in 1991 and were completed in 1992. Streams were first divided into uniform reaches based upon the system developed by Rosgen (1985). The habitat typing methodology developed by Bisson et al. (1981) and later modified by McCain et al. (1990) was then applied to each reach starting from the mouth of the stream working upstream. Twenty-two habitat types were available for characterizing any particular habitat unit. An individual habitat unit was equal to or greater in length than one wetted width of the channel to be considered an identifiable unit. The lengths, widths and depths of each habitat unit were measured using a hip chain, measuring tape and an incremental staff, respectively. Additionally, the maximum depth of the pool tail crest was collected for each pool to assist in establishing residual depth and volumes for such habitat units (Lisle 1987). Data were summarized for managed and reference watersheds, then stratified by stream order and channel type. ANOVAs were run on data sets from reference and managed watersheds.

Bull charr spawning surveys were conducted in early October of 1992 throughout much of the upper Spokane ecosystem by walking streams and counting observed redds and adult bull charr.

Results

In the St. Joe basin, 371 kilometers of tributaries and mainstem river were habitat typed; in the Coeur d'Alene basin, 351 kilometers. Seven St. Joe River tributaries were determined to be reference. Selected habitat types, by length, for the reference watersheds and managed watersheds in the two basins are displayed in Figures 2 and 3. In "A" channels, pocket water was the most common habitat type (55 percent by length) found in reference watersheds. In managed watersheds a significant shift from pocket water as the dominant habitat type, to riffle and braided habitat types was observed. In "B" channels of managed watersheds less pocket water and pool habitat and increases in run/glide and braided habitat was observed relative to reference watersheds. Mean residual pool volumes of pools (n=305) in reference watersheds differed significantly (p=.01) from residual pool volumes of managed watersheds (n=370). In second order "B" channels of entered St. Joe tributaries the mean residual volume of pools was 51 percent less than the mean value for pools of reference watersheds. In the "B" channel pools (n=423) of Coeur d'Alene River tributaries the difference in residual pool volume was 67 percent. Mean residual pool depth differed by 17 percent and 30 percent respectively. In "A" channels of managed watersheds, a similar significant difference in residual pool volumes (p=.05) and depths was observed when compared with reference streams; mean residual pool volumes differed by 26 percent and maximum pool depths by 27 percent.

Differences in habitat diversity were observed some major sub-basins of the Coeur d'Alene drainage. Figures 4 and 5 depict graphically the differences between second order "A" and "B" channel fish habitat composition between reference streams and managed streams of the Little

North Fork of the Coeur d'Alene. A trend away from habitat diversity can be noted.

In the St. Joe drainage, "B" channels of reference watersheds had RASI values ranging from 28 to 61 with a mean of 44 (Figure 6). St. Joe basin managed watersheds had RASI values that ranged from 65 to 99 with mean of 82. Twenty tributaries, reference and managed watersheds, to the St. Joe were surveyed for bull charr redds. Sixty-one redds were located in seven tributaries and the mainstem of the St. Joe River. With the exception of two redds, all bull charr redds were located in reference streams with RASI values less than 65.

Discussion

A review of the habitat requirements and ecology of cutthroat trout, other salmonids, and bull charr provides a basis for evaluating the significance of these data. Habitat requirements of salmonids including cutthroat trout and bull charr vary by age and season of the year (Baltz et al 1991; Moore and Gregory 1989; Rieman and Apperson 1989; Campbell and Neuner 1985). Young-of-the-year fish initially seek stream margins with heterogeneous habitat structure; where this habitat is not present or lost, juvenile trout populations are virtually eliminated (Moore and Gregory 1989). Dolloff and Reeves (1990) reported the young Dolly Varden (*Salvelinus malma*), a charr with similar habitat requirements of bull charr, most frequently used woody debris as cover. As fish grow larger and mature they seek out deep water habitat types such as pools and deep runs (Baltz et al 1991; Hickman and Raleigh 1982). During winter, cutthroat trout and bull charr typically seek deeper water associated with large woody debris and may spend more than 75 percent of their life history associated with pools (Moore and Gregory 1989).

There is strong evidence that shifts away from channel equilibrium can result in negative changes in the structure and function of stream ecosystems and their dependent fish populations (Bilby and Likens 1980; Schlosser 1982). Bisson and Sedell (1982) reported that where stream channels had become destabilized riffles elongated and in many cases extended through former pool locations resulting in loss of pool volume and large stable debris for cover. They suggested that declines in older fish may have resulted due to their dependency upon deeper water habitats.

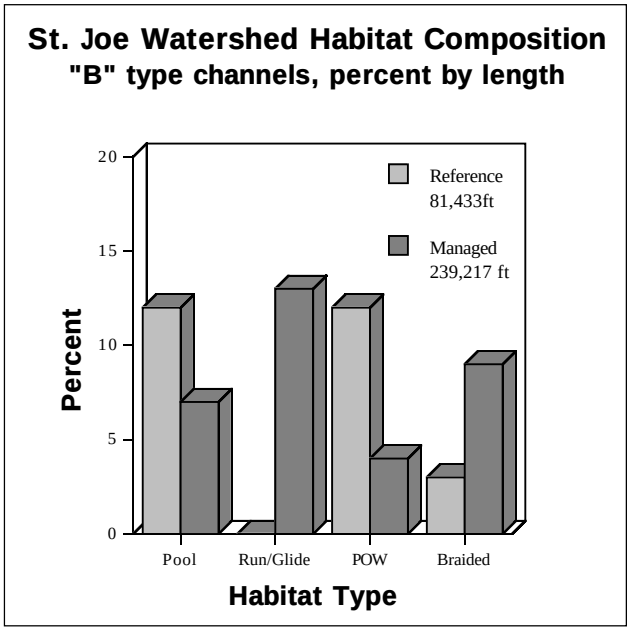

Figure 2. Comparison of selected habitat components in reference watersheds and managed watersheds in the St. Joe River basin of the Spokane ecosystem.

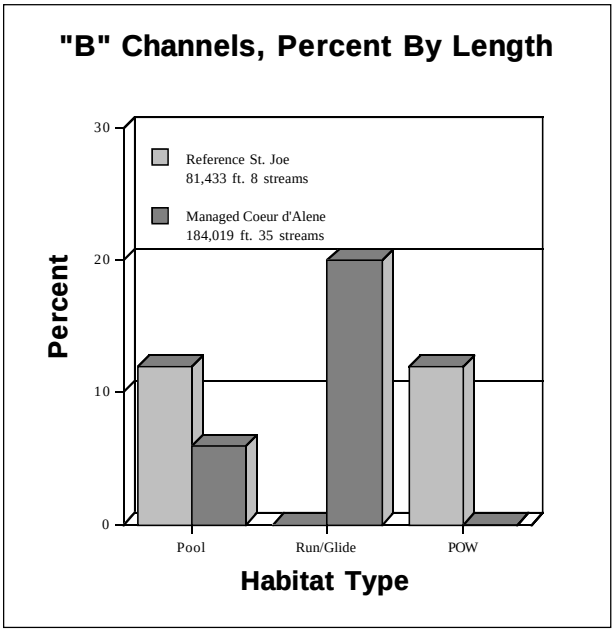

Figure 3. Comparison of selected habitat components in reference streams and the Coer d'Alene River basin of the Spokane ecosystem.

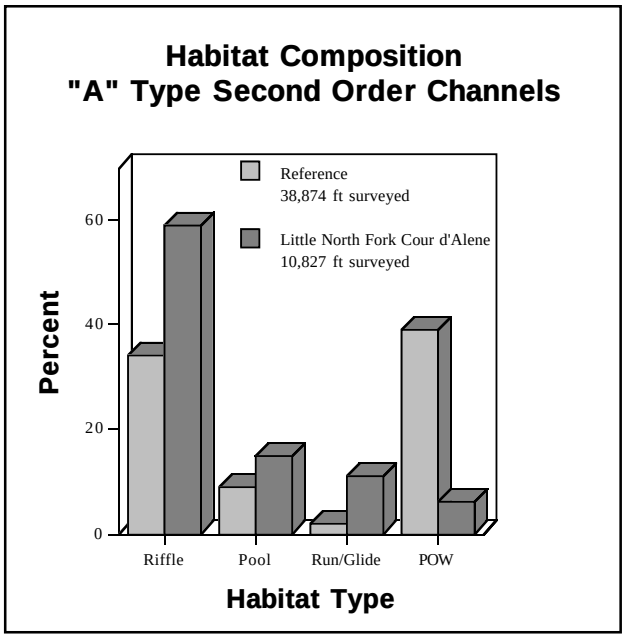

Figure 4. Comparison of major habitat components in reference streams and the Little North Fork Coeur d'Alene River from second order "A" type channels.

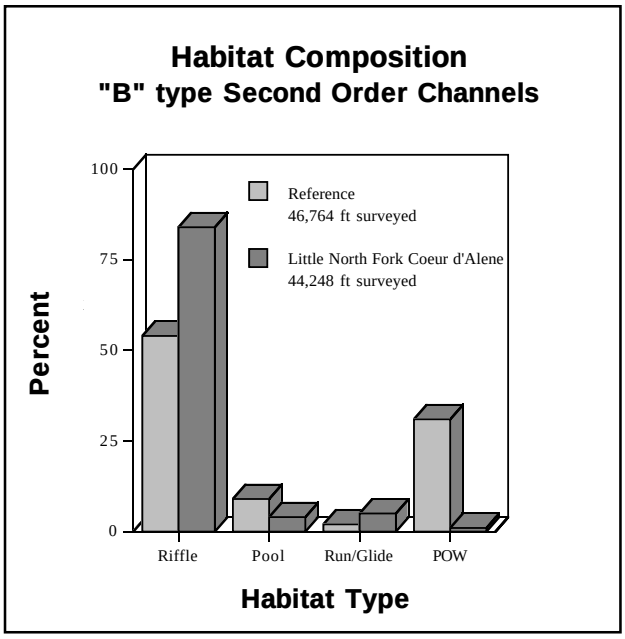

Figure 5. Comparison of major habitat components in reference streams and the Little North Fork of the Coeur d'Alene River from second order "B" type channels.

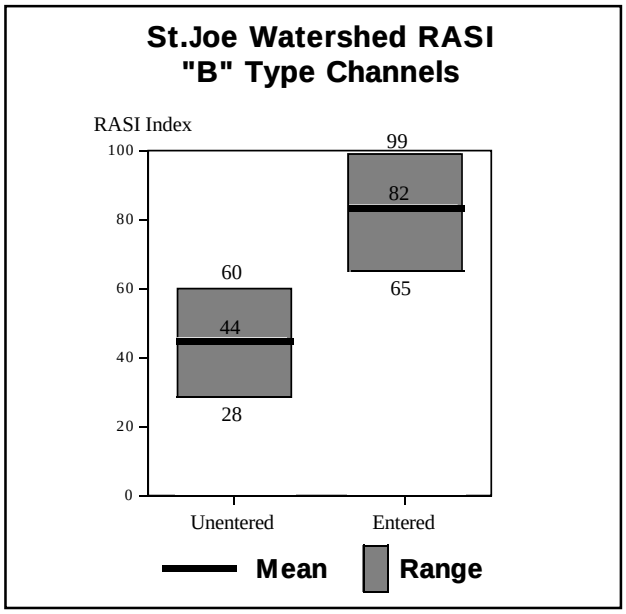

Figure 6. Range and mean of Riffle Stability Index values from reference and managed watersheds taken from second order "B" channels.

The function of headwater streams and their importance to downstream supported fisheries has been reviewed by Bilby and Likens (1980) and Schlosser (1982). Their work suggests that organic debris dams are a important component of small stream ecosystems and that their loss results in considerable seasonal and annual variation in the trophic structure and total biomass of aquatic ecosystems. In many of the managed watersheds of the Forests, headwater streams in the past were clearcut without benefit of a buffer strip and then burned in preparation for planting. This practice left many streams without a large organic debris component. The results of several researchers suggests that by maintaining lateral and instream habitat complexity in association with channel stability in multiple sub-watersheds we can best provide for the persistence of viable populations of these sensitive species over time (Karr and Freemark 1983; Karr and Dudly 1981; Gorman and Karr 1978).

Structurally diverse streams in watersheds un-modified by human activity typically have a great

deal of buffering capacity to sustain fish populations: channel pattern and bed configuration tend to moderate the effect of floods; pools in association with large woody debris offer refuges for fish during summer low flows and winter high flows; and canopy cover moderates thermal loading. Our data support the findings of Bisson and Sedell (1982) and Heede and Rinne (1990) and suggest the ecological processes that create and distribute fish habitat attributes, especially stream channel dynamic equilibrium, have been significantly modified by human activities. This is especially true in the Coeur d'Alene basin and some subbasins of the St. Joe. The observed differences in relative abundance of habitat types such as pools, riffles, pocket water and run/glides in reference and managed watersheds suggest that in managed watersheds sediment scoured from heavily roaded and harvested headwater channels is aggrading in lower reaches. The reference watersheds of this study experienced stand replacing fires in 1910 but are today in dynamic equilibrium. This leads us to conclude that today the Idaho Panhandle National Forests are dealing cumulatively with the direct and indirect effects of land management activities in synergism with natural disturbance events over the past ten decades or more which have resulted in widespread loss of stream channel integrity and modification of vital fish habitat. These changes have lead to the jeopardy of a unique fish in the upper Spokane River ecosystem, the bull charr, which was once common throughout the ecosystem but is today found in any strength in the upper St. Joe.

Westslope cutthroat trout are still present throughout the upper Spokane aquatic ecosystem although in varying population strength. Though declining, their population appears to have been more resilient to habitat changes perhaps because they are spring spawners, lower in the food chain, and probably more tolerant of changes in water temperature. No bull charr have been verified spawning in the Coeur d'Alene river in a number of years (Horner, Idaho Department of Fish and Game, personnel communication) but were widely distributed in the river in 1945 (Maclay 1940). The distribution of spawning bull charr in 1992 into streams with RASI values of less than 65 suggests to the authors that bull charr may show some selectivity of spawning sites with a preference to channels in dynamic equilibrium. The redds of fall spawning charr would be highly susceptible to loss in stream channels which are in disequilibrium and subject to winter rain-on-snow events which mobilize significant portions of the bedload at bankfull discharge, a common situation in the Coeur d'Alene basin from which bull charr now appear to be gone. With shifting bedload, eggs could easily be dislodged or deeply buried. Equally important, pools, critical to many portions of the life cycle of bull charr and other native fish such as the westslope cutthroat trout, appear to have a reduced volume and relative abundance in stream channels with high Riffle Armor Stability Indices, suggesting a loss in carrying capacity as channel integrity is lost. Fish population data collected by the Idaho Department of Fish and Game strongly suggest that the carrying capacity of the Coeur d'Alene River has been reduced relative to the St. Joe River (Horner, Idaho Department of Fish and Game, personal communication). Since pool habitat may be the last to recover in channels in disequilibrium (Kappesser, USDA Forest Service, personnel communication), maintenance of channels presently in equilibrium and recovery of stream channels in disequilibrium will be critical to the long term survival and recovery of stocks of bull charr and other native fish including the westslope cutthroat trout on the Idaho Panhandle National Forests.

It is unlikely that any of the impacted watersheds will recover quickly; existing conditions are the results of cumulative impacts of over 100 years of human activities and natural events, many prior to the establishment of the National Forests. In time, the recovery of impacted watersheds would provide many dividends, including reduced threat of extinction to bull charr, improved opportunities to harvest timber, reduced potential for flooding, restoration of stream channel integrity, and increased recreational fishing opportunities for future generations.

Literature Cited

Baltz, D.M., B. Vondracek, L.R. Brown, and P.B. Moyle. 1991. Seasonal changes in microhabitat selection by rainbow trout in a small stream. Transactions of the American Fisheries Society 120:2:166-176.

Bilby, R.E. and G.E. Likens. 1980. Importance of organic debris dams in the structure and function of stream ecosystems. Ecology 61:5:1107-1113.

Bission, P.A. and J.R. Sedell. 1982. Salmonid populations in streams in clearcut vs. old growth forest of western Washington. In: Meehan, W.R., T.R. Merrall, J.W. Matthews Eds. Fish and Wildlife Relationships in Old-Growth Forests. Proceedings of a Symposium. Amer. Inst. Fish. Res. Bios. pp 121-130.

Campbell, Ronald F. and J.H. Neuner. 1985. Seasonal and diurnal shifts in habitat utilized by resident rainbow trout in western Washington Cascade mountain streams. In: Forest Olson, Robert G. White, and R.H. Hamre Technical Eds. Proceedings of the Symposium on Small Hydropower and Fisheries. pp 39-48.

Cross, P.D. 1992. Memo to Forest Supervisor Re: Status of Bull Trout Populations of the Idaho Panhandle National Forests - Spring 1992.

Dolloff, C.A. and G.H. Reeves. 1990 Microhabitat partitioning among stream-dwelling juvenile coho salmon *Oncorhynchus kisutch* and Dolly Varden, *Salvelinus m alma*. Canadian Journal of Fisheries and Aquatic Sciences 47:2297-2306.

Gorman, O.T. and J.R. Karr. 1978. Habitat structure and stream fish communities. Ecology. 59:3:507-515.

Heede, B.H. and J.N. Rinne. 1990. Hydrodynamic and fluvial morphologic processes: implications for fisheries management and research. North Americal Journal of Fisheries Management 10:3:249-268.

Hickman, T. and R.F. Raleigh. 1982. Habitat suitability index models: Cutthroat trout. FWS/OBS-82/10.5. WELUT, Fort Collins, Colorado. 38 pp.

Kappesser, G. 1992. Riffle Armor Stability Index. Version 3.1. Idaho Panhandle National Forests. Coeur d'Alene, Idaho. 7 pp.

Karr, J.P. and D.R. Dudley. 1981. Ecological perspectives on water quality goals. Env. Man. 5:55-68.

Karr, J.R. and K.E. Freemark. 1983. Habitat selection and environmental gradients: dynamics in the "stable" tropics. Ecology. 64:6:1481-1494.

Lisle, T.E. 1987. Using "residual depths" to monitor pool depths independently of discharge. USDA Forest Service, Research Note PSW-394. 4 p.

Maclay, D.J. 1945. Tentative Fish Management Plan, Coeur d'Alene National Forest. 23 pp.

Moore, K.M.S. and S.V. Gregory. 1988. Summer habitat utilization and ecology of cutthroat trout fry in Cascade Mountain streams. Canadian Journal of Fisheries and Aquatic Sciences 45:1921-1930.

McCain, M.E., D.D. Fuller, L.M. Decker, and C.K. Overton. 1990. Stream habitat classification and inventory procedures for northern California. FHR Currents No. 1, USFS Region 5 Anadromous Fish Habitat Relationships Technical Bulletin. USDA Forest Service Pacific Southwest Region, S.F., California.

Schlosser, I.J. 1982. Trophic structure reproductive success, and growth rate of fishes in a natural and modified headwater stream. Canadian Journal of Fisheries and Aquatic Sciences 39:968-978.

Rieman, B. and K. Apperson. 1989. Status and analysis of salmonid fisheries: Westslope cutthroat trout synopsis and analysis of fishery information. Project F-73-R-11. Idaho Department of Fish and Game.

Rosgen, D.L. 1985. A stream classification system. In: Riparian Ecosystems and Their Management. First North American Riparian Conference. Rocky Mountain Forest and Range Experiment Station, RM-120, pp 91-95.

Royster, C. 1991. The Destructive War. Alfred A. Knopf, New York, New York. 523 pp.